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Stimulating transportation policy making through an effective traffic information communication mechanism: the case of Athens

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Abstract

The availability of accurate, up-to-date and timely transport and traffic information has become nowadays a crucial issue for decision makers and traffic planers, who wish to plan sustainable transport systems. The paper presents an online platform, the Observatory for Public Authorities and Transport Planners, providing traffic and transport aggregated data and corresponding indices to policy makers and transport planners, enabling the review of transport networks performance, the assessment of scenarios and the formulation of investment plans in order to create an effective and sustainable transportation system in their area.

Keywords: transportation policy making; traffic planners; observatory; transport and traffic indicators

1. Introduction

1.1. Background

Cities and metropolitan areas face ever increasing demands on their transportation systems, especially in developing regions with growing population and massive urban migration. Congestion, energy consumption, pollution and the need to increase transport system sustainability are top-priority problems

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in urban areas (Musso & Corazza, 2006). Even more than heavy infrastructure investment, strategic mobility management is becoming the most important tool for meeting this demand.

The term mobility management is used for strategies that result in more efficient use of transportation resources, as opposed to increasing transportation system supply by expanding roads, parking facilities, airports and other motor vehicle facilities. Mobility management emphasizes on the movement of people and goods, not just motor vehicles, and so gives priority to public transit, ridesharing and non-motorized modes, particularly under congested urban conditions (Litman, 2003). To be able to deliver effective travel plans and implement them, huge amounts of information about the use of the transport network are essential. Currently, traditional and new methods are used to provide traffic data. However, integration of such data is necessary so as to support innovative long-term planning and short term proactive and reactive management of the transport network.

Furthermore, given that road traffic is the main source of CO2 emissions in urban areas and that transport sector is one of the few sectors from which emissions are on the rise, due to the continuously growing demand for transport (Van Wee, Geurs, Van den Brink, & Annema, 1998), there is also a strong need for environmental data in transport planning and management.

1.2. The VIAJEO Project

The Project VIAJEO "International Demonstrations of Platform for Transport Planning and Travel Information", funded under the 7th Framework Programme of the European Commission, comes to answer to the previously analyzed needs, by bringing together various stakeholders to design, implement, demonstrate and validate a technological open platform in order to enhance efficiency of overall urban mobility. More specifically, the open platform will be able to:

- support the transport operations,
- plan a wide range of traveller information services;
- deliver dynamic information independent from the language to improve their provision of transport information and traveller services through integrated traffic data collection and management;
- deliver a solution that enables cross-modal journey planning, dynamic route guidance, effective payment access and improved personal mobility, etc.;
- Provide standardized interfaces to connect a variety of entities needed for the mobility services.

The open platform will facilitate the integration of components for data management allowing integration of European and local components as most convenient in four demonstration cities worldwide: Athens, Sao Paulo, Beijing and Shanghai. These cities have been carefully chosen to ensure that they have a reputation as national role models, allowing the results of successful demonstrations to be extended to other cities in these countries and also potentially to other countries in the respective continents. Regarding Athens in particular, the demonstration focuses on the collection of real-time traffic data for transport planning and real-time transport control, as well as multi-modal journey planner. For that purpose, three services are being implemented within the Athens pilot:

- Service A, which deals with taxi fleet management and traffic information, providing a dynamic assignment and navigation to taxi drivers, as well as alerts concerning traffic incidents on route.
- Service B, which provides an end-user multimodal trip planning and traffic information by delivering multimodal routes and presenting traffic information (i.e. travel times, traffic flows, road accidents) to end users via web and mobile phone applications.
- Service C, which establishes an Observatory for public authorities and traffic planners. The specific objectives and components of this service are outlined in the next sections of the paper.

1.3. The needs and priorities of transport and traffic planners

In large urban areas, transport and traffic planners often focus on improving car traffic flow and parking opportunities, while sometimes they recommend major new transit services, such as subways and commuter rail systems (Litman, 2003). However, they often overlook the cost effective opportunities to improve more basic transportation options, such as non-motorized travel conditions and bus services, even though these represent a major proportion of travel activity.

Road operators tend to favour measures that restrict and control car use while, in comparison, the public could welcome interventions that facilitate car use (Vreeswijk, van Bercum, & van Arem), such as the extension of particular roads. There exists however the possibility of the paradox, that an extension of the road network by an additional road can cause a redistribution of the flow in such a way that increased travel time is the result (Braess, Nagurney, & Wakolbinger, 2005).

Based on survey among the Organization for Economic Co-operation and Development (OECD) towns and cities in the nineties, the traffic problems are experienced very differently by different cities (OECD & ECMT, 1995). Where one city experienced congestion as very severe, another could report to have no congestion problems at all (Vreeswijk, van Bercum, & van Arem). Apart from the fact that cities are different, one explanation could be that traffic might be considered as a problem without having any quantitative figures that can support this opinion. An extensive survey (Bonsall, Beale, Paulley, & Petler, 2004) studied the diverse perspectives of road users and road operators where problems, priorities and solutions for road travel were examined. Many road users indicated that they felt that they, personally, were less negatively affected than other road users were, proving this way that problems in general are not as serious as generally perceived, which to a certain extent might be explained by media coverage of in particular bad news, and the tendency to recall negative rather than positive information.

One could easily conclude from the above that in order to solve the traffic problems in a particular city, the most important tool that transport and traffic planners should have at their disposal is the necessary transport and traffic information regarding modal shifts, available transport modes, routes and timetables, CO2 and other emissions, etc. Furthermore, the availability of advanced Information and Communication Technology (ICT) services for users of both the road and public transport networks could contribute to the minimizing of unnecessary trips, as well as to the efficient use of available transport modes road networks in the particular urban environment.

1.4. Aims of the paper

Responding to the above needs for efficient urban mobility management and traffic information availability and provision to policy makers, the present paper aims to outline the particular needs of the city of Athens, which comprises one of the four pilots of the VIAJEO Project. More specifically, the transport set up in Athens will be described, in terms of available transport modes, traffic management centres, missing data, etc. The results of an investigation conducted in the framework of the project, examining the perception of local transport and traffic planners as regards the situation and needs of the city will also be provided.

Coming to the core part of the paper, the Observatory for Public Authorities and Transport Planners, comprising one of the three services of the Athens pilot site will be described. An overview of the Observatory will be provided along with the most important transport indices made available to the planners. Finally, a typical use case of the Observatory will be described.

In the concluding chapter, finally, the benefits of the particular service will be assessed, along with the provision of recommendations for potential exploitation.

2. The case study in Athens

2.1. Short outline of transport and traffic system

Athens is the Greek capital, with a population of 3,130,841 inhabitants in its greater urban area (Attica region). The Attica region extents to a land area of 412 km^2, while being the centre of the economic, financial, industrial, political and cultural life in Greece.

The mass transit system of Attica is the largest transit system of Greece and one of the most complex transit systems in Europe. Since the latest 1990's, the financing of transport infrastructure, which came to its peak due to the Olympic Games of 2004, has led to the development of a modern region-wide transport network (Michaelides, Belegri-Roboli, & Marinos, 2010) consisted of six transit modes:

- The Underground Railway, which is operated by the "Attiko Metro Operation Company" (AMEL), a subsidiary company of ATTICO METRO S.A. Today the Attiko metro is the most popular transit mode in Athens, serving approximately 650,000 passengers per day, in a railway network of 51.1 km (AMEL-Athens Metro Operation: Athens Metro Operation Company website, 2010).
- Thermal Buses that fall under the responsibility of ETHEL SA. The fleet of Thermal Buses in the Attica region numbers 2,148 buses, serving 319 bus lines, which cover a transit network of 8,500 km long (ETHEL S.A., 2010).
- The Electric Railway that operates under "Athens – Piraeus Electric Railways S.A." responsibility. Today, a railway line of 25.6 km serves approximately 450,000 passengers on a daily basis (ISAP-Athens Piraeus Electric Railway, 2010).
- Trolley Buses that serve 23 lines of 350 kilometres in the Attica region, under the operation of ILPAP (HLPAP-Trolley Bus in Athens-Piraeus Area S.A., 2010).
- The Urban Railway (Tram) that operates within a network of 27 km, serving 65,000 passengers daily (TRAM SA, 2010).
- The Suburban Railway that provides its services by TrainOSE, the national railway operator, connecting the sub-urban regions of the greater Attica region (ΤΡΑΙΝΟΣΕ, 2010).

The general organizational framework regarding the Attica region's transit system is provided in Fig.1.(a). As can be seen from the figure, the Athens Urban Transport Organization (OASA S.A.) is the legal entity that plans, co-ordinates and controls through its affiliate companies all surface and underground public transport modes in the greater Athens area.

Regarding the traffic characteristics within the Greek capital, the single mode daily trips for the Athens Metropolitan area present an increasing trend during the last decade – indicatively, from 6,300,000 in 2001 (presenting an increase of 29% during the years 1990 – 2001) (Stathopoulos & Karlaftis, 2001) to 8,000,000 in 2005 (Handanos & Kopsachili, 2008) and this number was expected to outreach the 10,000,000 within the year 2011.

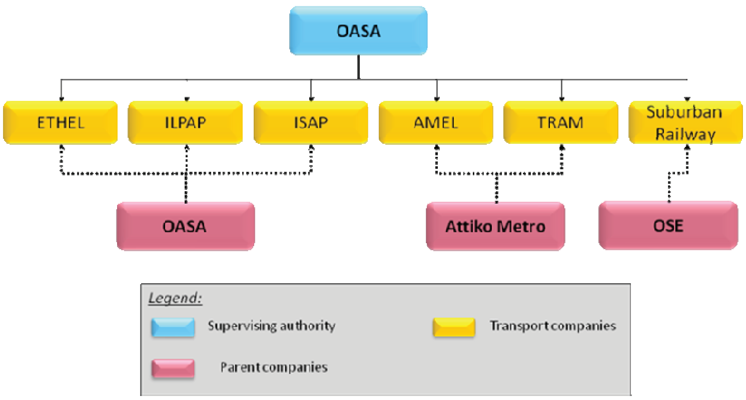
Fig. 1 (b) illustrates the allocation of the trips into the various transport modes. The private car is the dominant mean of transport, accommodating approximately 45% of the transport modal split in Athens (OASA, 2006).

As for the current situation of traffic data collection in Athens, two traffic control and management centres exist nowadays in Athens:

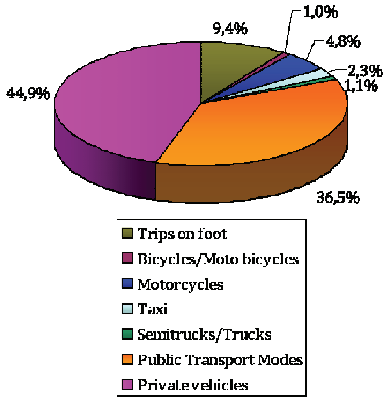
- The Athens Traffic Management Centre (ATMC). ATMC is legal entity of public law, established by the General Secretariat of Public Works of the Greek Ministry of Infrastructure, Transport and Networks that deals with the monitoring of traffic conditions in main roads of Athens, the adoption of measures for dealing with emergency incidents (accidents, vehicles immobilizations, abstractions, works in progress, events, etc.) and the provision of real time traffic data concerning the traffic conditions to the drivers.

- The Traffic Management Centre of Attiki Odos S.A., which is a legal entity of private law that monitors the traffic conditions in the high-speed toll motorway of Attiki Odos.

Both centers use high-technology equipment in order to collect the relative traffic data (closed-circuit TV cameras, ground loop detectors, etc.), as well as to process it and display it to the end user (through variable message signs, lane control signs, variable speed limit signs, etc.).



(a)



(b)

Fig. 1. (a) Organization of the Public Transport System in the Attica Region; (b) Allocation of the trips into the various transport modes within the prefecture of Athens (OASA, 2006)

2.2. The opinion of local traffic planners

During the current situation analysis of the VIAJEO project, a thorough survey was conducted in order to examine the views of transport planners regarding the provision of traffic information in the city of Athens. The investigation was not only focused on traffic information, but also on general challenges that the city of Athens faces and possible solutions to them. These challenges refer to the need:

- To reduce traffic loads in the main city roads, in order to address the immense problem of traffic congestion in the centre of the city and in other major surrounding areas.
- To increase the share of public transport modes by improving their interoperability.
- To stimulate cooperation between the providers of information regarding the road network and the ones providing information on public transport modes, in order to promote an holistic traffic information system.
- To efficiently manage the surveillance of parking restrictions that contribute to the severity of traffic congestion.
- To efficiently manage traffic incidents, especially with regards to their contribution in traffic congestion.
- To improve the accessibility of the mobility impaired people to the various transport modes.
- To promote an environmental friendly and cost effective transportation for the citizens.

Concerning the aforementioned challenges, all traffic planners that were interviewed agreed that the solution cannot be found in the construction of new roads, but in the better planning of the public transport network (that will, among other measures, include the extension of the metro lines and the improvement of the quality of transportation services), the better surveillance of drivers in the city centre (e.g. trespassers of bus lanes), the higher use of Intelligent Transportation Systems (ITS) (i.e. High Occupancy Vehicles (HOV) priority measures, extensive use of traffic information through Variable Message Signs (VMSs), etc.) and the provision of high-quality traffic information.

Concerning the latter, the traffic planners mentioned the accuracy of the information that is currently provided by the two traffic control and management centres and, therefore, they highlighted the various VMSs installed in Athens as currently being the most successful mean of real-time traffic data provision in the Greek capital. Nonetheless, previous studies in Athens Metropolitan area (Tsirimpa & Polydoropoulou, 2009) indicated that although a very high percentage of the drivers (end users) are aware of the VMS in Attica, only a small number of them (30%) stated that the VMSs have somehow influenced their overall travel behaviour. To the contrary, end users seem more willing to use information from other sources like radio, either prior to their journey or en route.

Apart from the above, the traffic planners placed particular emphasis on the need for data so as to ensure structured decision making. More specifically, the representative from the Directorate of Road Studies of the Ministry of Infrastructure Transport and Networks mentioned that the types and requirements of data needed for strategic transport planning mainly concentrate on hourly traffic loads and raw data regarding peak hours, daily and seasonal traffic flows, and other relevant information. The officers from the Athens Urban Transport Organization mentioned that it would be very useful if a system was available that would process the existing data and provide indices for more appropriate for decision making. Finally, the representatives from the Directorate of Road Studies also stressed the need to expand the road network equipment for collecting traffic flows and the existing software for data processing, as well as the network for data transmission so as to ensure the interoperability between the existing traffic centres (Kortsari, Tyrinopoulos, Mizaras, Sarros, Milli, & Psomadelis, 2010).

3. Presentation of the Observatory for Public Authorities and traffic planners

3.1. Overview

The objective of the “Observatory for Public Authorities and Traffic Planners” service (Service C) is to provide to traffic planners, public authorities, transport companies and other relevant stakeholders a well-organized data mechanism (Observatory) and content that will help them to estimate the status of the transportation system in Athens and support their policy making process. This will be achieved by providing data and indices about the traffic and transport conditions.

The above service is based on an existing web-based application (entitled PORTAL), which is operated and maintained by the Hellenic Institute of Transport (HIT). PORTAL provides various services such as: a *Transport Observatory* for the provision of traffic data*, Traffic Forecasting and Network Simulation* for realizing various transport scenarios, *Scheduling and Freight Urban Routing* for routing of vehicles and drivers in urban and suburban environments, *Testbed* for testing algorithms and other research results developed by research and academic institutions, and more.

The service contains two core functionalities:

- <u>Traffic content management</u>: The real time traffic data collected and used in the Services A and B (described in section 1.2) are archived in the Observatory and combined with the existing historical data (HIT’s PORTAL). The data is further processed providing to traffic planners and authorities aggregated information about the traffic situation in Athens.
- <u>Transport and traffic indices</u>: On top of the content of the Observatory, transport and traffic related indices have been defined and measured delivering strategic planning and service quality and performance information to traffic and transport planners.

The service is being fed by data provided by many different sources in various formats such as XML - SOAP, direct SQL database connections, database replication, that systematically collect and provide raw data (Real time traffic data, historical data, transport and traffic data provided by traffic indices).

3.2. Traffic Indices

The core component of the Observatory is the indices defined in order to be able to capture an integrated picture about the traffic and transport conditions in Athens and traffic planning and decision making. These are presented in Table 1. The indices mainly refer to traffic and accidents, since this kind of information is of vital importance for the Athens transportation system.

Table 1. Traffic indices

No	Indicator	Description
1	Number of reported accidents of motor vehicles that include injuries	Number of accidents that include fatal, heavy and light injuries.
2	Region road safety indicator per 10,000 vehicles or per 100,000 residents	Total number of reported accidents of motor vehicles that include injuries (deaths, heavy, light) per 10,000 vehicles or per 100,000 residents.
3	Region road safety indicator per road type/paving type/etc.	Total number of reported accidents of motor vehicles per 10,000 vehicles (or 100,000 residents) and per road type (i.e. national road, rural road, municipal or community road, highway, speedway, other). Similar indices refer to paving type, environmental conditions, paving conditions, paving state, night lighting, type of vehicles involved, accident type, manoeuvre type that caused the accident and type of traffic control.
4	Indicator of accidents per million of vehicle km	Total number of reported accidents of motor vehicles per 1,000,000 vehicle kilometres.
5	Death rate per 10,000 vehicles or per 100,000 residents	Ratio of reported deaths from motor vehicle accidents to number of vehicles or residents.
6	Pedestrian death rate per 10,000 vehicles or per 100,000 residents	Ratio of reported pedestrian deaths carried away from motor vehicles to number of vehicles or residents.
7	Region accident weight indicator per 10,000 vehicle or per 100,000 residents	Number of persons injured during motor vehicles accidents per 10,000 vehicles or per 100,000 residents (injuries categorized heavy and light).
8	Region accident weight indicator per vehicle kilometres	Number of people injured in road accidents per 1 million vehicle kilometres. Injuries can be considered as fatal, heavy and light.
9	Network segment accidents weight indicator	Number of people injured (fatally, heavily or lightly) for a specific time period in a specific road segment.
10	Severity of accident	Number of accident including deaths in relation to the total number of accidents.
11	Road safety indicator based on the average speed	Number of total accidents reported in a specific road segment for a specific time period, categorized by the average speed.
12	Road safety indicator based on the road density	Number of total accidents reported in a specific road segment for a specific time period, categorized by the density of the road segment.
13	Road safety indicator based on the	Number of total accidents reported in a specific road segment for a specific time

No	Indicator	Description
	traffic flow	period, categorized by the traffic flow.
14	Average traffic flow on a specific journey	The average traffic flow on a specific journey.
15	Total time spent on a specific journey	The time taken to travel between 2 specified points, by a specified route, including any time taken by involuntary stops and delays.
16	Average journey speed	The average distance travelled per hour, calculated over the whole journey.
17	Average journey time	The sum of the average journey times on all the sections of the journey (Pajouh-Danech, 2001).
18	Peak hourly factor indicator	The hourly volume during the maximum-volume hour of the day divided by the peak 15-minute flow rate within the peak hour.
19	30th maximum value of the hourly volume	The 30th maximum value of the hourly volume in a specific road segment during the period of one year.
20	Yearly variation of the volume	Percentage of increase or decrease of the Medium Daily Hourly Volume of a road segment for the same day between 2 successive years.
21	Average Annual Daily Traffic	Fraction of the total number of vehicles going through a specific spot or segment of the road during a year to the total number of days of the year.
22	Annual Daily Traffic	Fraction of the total number of vehicles going through a specific spot or segment of the road during a specific time period to the total number of days of the period.
23	Monthly variation of traffic	Comparison of the traffic flow in a particular road segment in various months in the same year or in the same month during different years.

3.3. Use of the Observatory

In order to acquire any traffic related information or indicator from the Observatory, first the user has to register to the system and acquire his personal user name and password. Registration is done with the use of a web form and after the user fills in a minimum set of personal data (name, organization, contact information, etc.). After the password is acquired, the user is able to access the service, navigate through the provided portal, select the traffic information and indicator of his preference and receive the desirable information in various forms (charts, map, etc.).

Most of the indices require by the user the selection of calculation criteria, which are mainly provided through drop-down lists. For the accident indices, for example, seven areas of selection are included in the calculation form, from which the user can choose the geographical and time-period criteria of his preference, the type of accident (fatal, heavy, etc.), the accidents' nature (vehicle & vehicle, vehicle & pedestrian, etc.), the report unit (100,000 residents, 10,000 vehicles, etc.) and whether or not the indicator will be based on the number of accidents or the people involved in the accidents. The user can also activate some further criteria concerning, for example, the type of the road, the environmental conditions during the accident, etc.

In order to provide an example, it is assumed that the user wishes to acquire the region accident weight indicator for fatal injuries, for the municipality of Chalandri (Attica region), for the year 2008. He then has to select "Region Road Safety Indicator" and the relevant form is opened, with all the selection criteria available. The user then selects Indicator based on "People involved in accidents", Type of Injury "Fatal", Prefecture of "Athens", Municipality of "Chalandriou", From Date "January 2008" and To Date

“December 2008”. The Observatory, then, returns the requested information as can be seen in Fig. 2 (a map is used in order to visualize the selected area or road segment). The option of displaying the outcome in form of charts is also provided.

Further to the above, the Observatory provides outcomes in forms of charts, displaying both the yearly and monthly variation of some indices.

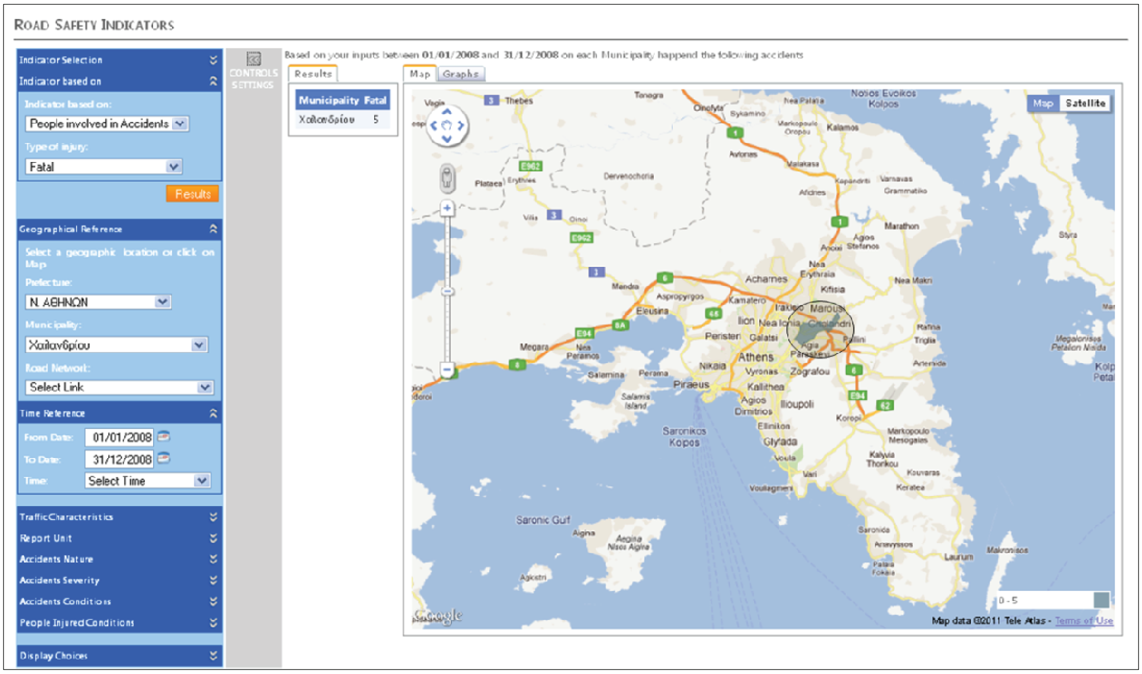


Fig. 2. An example of an accident indicator provided by the VIAJEO Observatory

3.4. Stimulating transportation policy making

The emphasis on the need for data that will ensure a structured transportation policy and decision making has already been pointed out by Greek transport planners and policy makers, as previously stated in sections 1.3 and 2.2. Transport and traffic related indices and statistics, provided by the Observatory, could enable the clear definition of the problems/issues that the policy making should address, thus justifying the necessity of interventions and investments. They also provide those valuable data input in order for the policy/strategy options to be formulated (i.e. input for multi-criteria analyses), assessed and finally, successfully implemented, always in accordance to the performance information that is provided for the transport network in question.

Furthermore, defined transport and traffic indicators could measure the ‘before’ and ‘after’ situation, thus forming a valuable tool for the monitoring and evaluation of the policy measures that have been applied. They can also be used for scenarios building and assessment that will guide future investments on major transportation infrastructures.

The Observatory supports the provision of single-source, aggregated, accurate, comprehensive and up-to-date data in various forms (chart, maps, tables), thus addressing the demand of modern transport planning in data availability and provision (an easy-to-access tool).

4. Conclusions

Traditionally, policy making in transportation planning requires extensive amount of primary and secondary data that cover a wide range of aspects, such as land use, networks characteristics, demographic information, environment and many more. Furthermore, the responsible policy and decision makers clearly state that they require tools and a vast volume of diverse data that will allow them to gain a sound picture of the area under study. These two pillars, i.e. data and tools, consist the backbone of any transportation planning and respective decision making.

Modern transport planning demands multiple tools, such as traffic models, scheduling algorithms, ITS applications, etc., that will provide a complete view of the current and evolving conditions of the areas where interventions and investments are necessary. On the other hand, the data that feed all these tools have to be up-to-date, comprehensive and accurate, while reflect the emerging conditions of cities, such as migration. With these tools and data, the responsible transport and traffic planners can define and assess scenarios and investment plans in order to create an effective and sustainable transportation system.

The Observatory presented in this paper provides some important advantages to traffic planners and policy makers, since it provides:

- Accurate, comprehensive and up-to-date data.
- Transport and traffic indices and statistics delivering strategic planning and service quality and performance information to traffic and transport planners.
- A user-friendly and easily accessible mean, through which the traffic planners and policy makers can obtain aggregated data and indices in various forms, i.e. charts, maps, tables.

The above create a useful tool able to support and facilitate policy and decision making process in transport planning. The direct access to a source of primary and secondary data enabling the minimization of the risk of multiple sources is another advantage of the Observatory.

Concluding, the Observatory addresses proven needs and priorities of traffic planners and policy makers. This tool cannot replace existing databases or related software. However, it can provide supporting information that is not possible to be collected, updated and maintained by a public authority or traffic planner.

References

AMEL-Athens Metro Operation: Athens Metro Operation Company website. (2010). Retrieved 2011, from http://www.amel.gr

Bonsall, P., Beale, J., Paulley, N., & Petler, A. (2004). Evaluating problems, priorities and solutions for road travel: the differing perspectives of users and service providers. *European Transport Conference.* Strasbourg, France.

Braess, D., Nagurney, A., & Wakolbinger, T. (2005). On a Paradox of Traffic Planning. *Transportation Science , 39* (4), 446-450.

ETHEL S.A. (2010). Retrieved 2011, from http://www.ethel.gr

Handanos, I., & Kopsachili, A. (2008). Views of the Hellenic Institute of Transportation Engineers over an itinerary for Athens transport of the next decade: from congestion to a sustainable mobility. *Mobility in urban areas. The Green Paper and the Greek reality.* Athens: Technical Champer of Greece.

HLPAP-Trolley Bus in Athens-Pereaus Area S.A. (2010). Retrieved 2011, from http://www.athens-trolley.gr

ISAP-Athens Piraeus Electric Railway. (2010). Retrieved 2011, from http://www.isap.gr/

Kortsari, A., Tyrinopoulos, Y., Mizaras, V., Sarros, G., Milli, M., & Psomadelis, F. (2010). *D6.1.1 Investigation.* VIAJEO.

Litman, T. (2003). *Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Module 2b: Mobility Management.* GTZ Transport and Mobility Group.

Michaelides, P., Belegri-Roboli, A., & Marinos, T. (2010). Evaluating the Technical Efficiency of Trolley Buses in Athens, Greece. *Journal of Public Transportation , 14* (4), 93-109.

Musso, A., & Corazza, M.-V. (2006). Improving Urban Mobility Management: Case Study of Rome. *Journal of the Transportation Research Board , 1956*, 52-59.

OASA. (2006). Retrieved 2011, from http://www.oasa.gr

OECD, & ECMT. (1995). *Urban travel and sustainable development.* Paris: OECD.

Pajouh-Danech, M. (2001). Road traffic indicators as a performance guide. *Traffic Engineering & Control , 42* (9).

Stathopoulos, A., & Karlaftis, M. (2001). Temporal and Spatial Variations of Real-Time Traffic Data in Urban Areas. *Transportation Research Record: Journal of the Transportation Research Board , 1768*, 135-140.

TRAM SA. (2010). Retrieved 2011, from http://www.tramsa.gr

Tsirimpa, A., & Polydoropoulou, A. (2009). Travelers response to VMS in the Athens Area. *Prospects for Research in Transport and Logistics on a Regional-Global Perspective* (pp. 179-187). Istanbul: Dogus University.

Van Wee, B., Geurs, K., Van den Brink, R., & Annema, J. (1998). Transport and the environment: the contribution of national and local policies. *Environmental Pollution , 102*, 663-670.

Vreeswijk, J., van Bercum, E., & van Arem, B. (n.d.). Priorities in Urban Traffic Problems and Implications for the Design of Solutions.

ΤΡΑΙΝΟΣΕ. (2010). Retrieved 2011, from http://www.trainose.gr/